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AGE AND GROWTH OF PIKE PERCH *SANDER LUCIOPERCA* (PERCIDAE) IN THE GHRIB RESERVOIR (NORTHWEST ALGERIA)

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RESUME.— *Âge et croissance du Sandre* Sander lucioperca (Percidae) *dans le réservoir de Ghrib (Nord-Ouest Algérien).*— L'objectif de cette étude était de déterminer les paramètres de base spécifiques aux populations nécessaires à l'évaluation des stocks de poissons dans le barrage de Ghrib et de les comparer avec des données provenant d'autres régions. L'âge et la croissance du Sandre, *Sander lucioperca* (Linnaeus, 1758), ont été étudiés mensuellement de mai 2013 à avril 2014 dans ce barrage algérien, à partir de 849 spécimens. En utilisant la méthode scalimétrique, nous avons pu identifier 9 groupes d'âge dans la population échantillonnée ($21 < L_t < 88,2$ cm). Les relations taille-poids entre la longueur totale (L_t) et le poids (W) ont été établies pour la masse brute et la masse éviscérée, sexes séparés et sexes confondus, soit dans ce dernier cas : $Wt = 0,0033\ L_t^{3,237}$ ($77 \leq Wt \leq 7245$ g) et $We = 0,003\ L_t^{3,271}$ ($59 \leq We \leq 6229$ g). La taille du poisson au moment de l'apparition des écailles a été estimée à $L_{t0} = 78,86$ mm. Les valeurs moyennes des tailles de poisson obtenues par rétro-calcul à chaque formation des anneaux s'adaptent bien au modèle de croissance de Von Bertalanffy : $L_t = 125,72\ (1 - e^{-0,13\ (t + 1,29)})$. L'indice de performance de croissance (φ) est de 3,31. Les paramètres de croissance déterminés par la méthode de Bhattacharya s'ajustent bien au modèle de croissance de Von Bertalanffy : $L_t = 132,17\ (1 - e^{-0,12\ (t + 1,69)})$. Le test $\chi 2$ appliqué aux résultats des deux méthodes n'a pas montré de différence significative.

SUMMARY.— Our objective was to estimate growth parameters for Pike perch *Sander lucioperca* (Linnaeus, 1758) in the Ghrib reservoir. Additionally, we compared these values with those from populations in other regions. We collected 849 pike perches ($21 < TL < 88.2$ cm) from May 2013 to April 2014. Direct scale readings were performed by counting the number of rings, and the results were compared with data obtained by back-calculating the length at different ages. The individuals in the sample were aged between 1^+ and 9^+. Size-mass relationships were calculated for the total mass and the eviscerated mass: $TW = 0.0033\ TL^{3.237}$ ($77 \leq TW \leq 7245$ g) and $EW = 0.003\ TL^{3.271}$ ($59 \leq EW \leq 6229$ g). The mean size of fish at the time of first scale formation was estimated as $L_{t0} = 78.86$ mm. The median values of the fish sizes obtained by retro-calculation were consistent with the Von Bertalanffy model of growth: $TL = 125.72\ (1 - e^{-0.13\ (t + 0.89)})$. The growth performance index (φ) was 3.31. The parameters of growth determined by the Bhattacharya's method were consistent with the Von Bertalanffy growth model: $TL = 132.17\ (1 - e^{-0.12\ (t + 0.95)})$. The $\chi 2$ test applied to the results of the two methods did not show any significant difference.

In Algeria, Percidae are represented by two species: *Sander lucioperca* (Linnaeus, 1758) and *Perca fluviatilis* (Linnaeus, 1758). *Sander lucioperca* is a European species that was historically distributed from Elba and the Baltic Sea in the east to South-West Russia in the west (Deelder & Willemsen, 1964; Sonesten, 1991; Campbell, 1992). Currently, the species is found in the area from the Iberian peninsula to the Sea of Aral and from Scandinavia to the Maghreb countries. Additionally, it has been introduced in the Azores and into certain lakes of the United States (Poulet, 2004).

In 1985, specimens from Hungary were introduced to Lake Oubéira and reservoirs in the north of Algeria, including Ghrib reservoir, to supplement the native fish fauna and aid development of aquaculture (Meddour *et al.*, 2005; Kara, 2012). The species currently supports a robust and economically important fishery for individual and commercial fishers in the region.

However, introduction of pike perch has resulted in conflict in some areas of the region (Cowx, 1997). Although the establishment of this species has allowed commercial fishing seasons and angler harvest in many countries (Dahl, 1984), it has also disrupted the native fish assemblage in many locations. For example, its introduction into Lake Egridir in Turkey caused the extinction of three species of *Phoxinellus*, of which two were endemic (Crivelli, 1995).

To balance both fishery and conservation objectives, there is a need to develop management plans for *S. lucioperca*. Development of such plans relies on an understanding of size, age structure, and growth characteristics of populations under consideration (Laurec & Le Guen, 1981; Meunier, 1988). The majority of studies on *S. lucioperca* to date have focused on populations located around the Baltic Sea and in Scandinavia (Nagiec, 1977; Lehtonen, 1983; Kangur & Kangur 1996; Hahlbeck & Müller, 2003; Ložys, 2004 and Milardi *et al.*, 2011). In the more southerly regions and/or recently colonized areas, the demographic characteristics of *S. lucioperca* are less well studied (but see Toujani, 1998; M'Hetli, 2001; Poulet, 2004; Argillier *et al.*, 2012; Pérez-Bote and Roso, 2012).

Our objective was to measure the growth of this species in the Ghrib reservoir, Algeria, a location outside the native range of the species. Our results can be used to inform stock assessment analyses for this area.

MATERIALS AND METHODS

STUDY SITE

The study was conducted in the reservoir upstream of the Ghrib dam, which is located in the south of the wilaya of Ain Defla, 150 km from Algiers. The reservoir has a catchment of 22 456 km². Established on Oued Cheliff (36°13'76.77" N and 2°56'70.01" E), it is delimited at the downstream end by the Boughzoul dam, which acts on it as a settling pond (Fig. 1). Water temperatures in this area fluctuate from 6.5°C in winter to a maximum of 30°C in summer.

FISH SAMPLING

Currently, the fish assemblage in Ghrib reservoir includes eight fresh-water species: *Barbus callensis* (Barbell), *Rutilus rutilus* (Roach), *Carassius carassius* (Crucian carp), *Abramis brama* (Bream), *Cyprinus carpio* (Common carp), *Hypophthalmychtys molitrix* (Silver carp), *Hypophthalmichthys nobilis* (Bighead carp), and *Sander lucioperca* (Pike perch). In December 1990, 8 barbels were captured from the Ghrib reservoir but only one pike perch. In June 1991, 5 barbels were captured (Arab work, unpublished). In 2013, we noted a predominance of carps (10 565 were captured: 1945 in June and 2210 in December), pike perches (2603: 173 in June and 990 in December), and native species such as the barbell (1510: 162 in June and 435 in December). In 2014, we captured 12 060 carps (1870 individuals in June and 1280 in December), 4232 pike perches (564 individuals in June and 635 in December), and 1221 barbells (103 individuals in June and 130 in December).

Samples of *S. lucioperca* were collected monthly from May 2013 to April 2014 in the Ghrib Reservoir by setting gill nets (18, 25, 35, 45 and 65 mm mesh size). The nets were set at the surface in the evening at ~5 p.m., and retrieved the next morning at around 6 a.m., then again at 12 a.m. Fish were immediately transported to the laboratory and measured for total length (TL; to the nearest lower 0.1 cm); fork length (FL; to the nearest lower 0.1 cm); standard length (SL; to the nearest lower 0.1 cm); total weight (TW; to the nearest 0.001 g); eviscerated weight (EW; to the nearest lower 0.001 g), and sex. Several scales (10-20) were removed from the area below the pectoral fin, cleaned with KOH 5% and rinsed with distilled water, then stored dry in individually labelled plastic vials. The scales were held between two blades and observed with a binocular magnifying glass. Readings were made by three independent observers; the scales were used in subsequent analyses only when all three readings were in agreement.

The morphometric relationship between TL or FL and scale-size were of the type $Y = aX + b$. The relationship between length and weight was described by: $W = a \times TL^b$ (Ricker, 1973), where W is the total weight (TW) or the eviscerated weight (EW) in grams, *a* is the intercept, *b* is the slope (fish growth rate), and TL is the total length in centimetres. Differences in the relationship between total length and total weight between sexes were tested using ANCOVA. We tested for isometric growth using a *t*-test. A marginal increment analysis was used to validate annual growth increment formation (Beamish & McFarlane, 1983). The monthly mean of the marginal increment (MI) was calculated using: $MI = (R - R_n) / (R_n - R_{n-1})$. R, R_n, and R_{n-1} are, respectively, the radius, the radius of the last and the next-to-last growth rings. Monthly values of MI were compared using a one-way ANOVA test, followed by a multiple sample comparison of means (Dagnelie, 1975).

Figure 1.— Location of the study site, Ghrib reservoir, Algeria.

The age-length relationship was back-calculated using the Lee method (1920). The relationship between fish length (TL) and total scale radius (*R*) was obtained by a regression TL = f (R) based on 230 scales ($21 \leq TL \leq 88.2$ cm; $0.57 \leq R \leq 6.24$ mm). Sizes-at-age (age-length key) were compared with the results of the back-calculation. The growth values obtained by scale measurement were analysed and compared with those of the theoretical growth calculated according to the model of Von Bertalanffy (1938) using FiSAT II (version 1.2.2) (Gayanilo *et al.,* 1996). The model was expressed by the equation: $TL = L_\infty (1 - e^{-k (t - t_0)})$, where TL is the size of fish at the moment t, L_∞ is the theoretical maximum size that the fish is likely to reach, and t_0 is theoretical time when TL = 0. Sample manpower was classified per month and class of size (5 cm interval). Absolute growth was calculated based on analysis of size distribution modes. The various modes correspond to pseudocohorts of different ages. For this analysis, we used FiSAT II (Gayanilo *et al.,* 1996), which allows estimation of L_∞ growth, K, and t_0 (Bhattacharya, 1967). These parameters were adjusted using the Von Bertalanffy equation and were compared with those obtained by the direct method of estimating growth. A growth performance index ($\varphi' = \log k + 2 \log L_\infty$) was calculated to compare the results obtained in this study with results published elsewhere (Pauly & Munro, 1984).

RESULTS

A total of 891 scales were used to assess fish age. Age was assigned for 849 (95.28 %) scales: 375 females, 474 males (Tab. I). The range in total length and total weight for female and male fish was 21.8 - 83.8 cm and 86 - 4935 g, and 21.0 - 88.2 cm and 77 - 7245 g, respectively. The length-length and weight–length relationships are summarized in Table I. The equations expressing the length–weight relationship for pike perch were indicative of positive allometric growth for both sexes (paired *t*-test, females: *t*-test = 5.26, $P < 0.05$; males: *t*-test = 2.99, $P < 0.05$). The allometric coefficient of the regression in females was significantly higher than in males (ANCOVA, F = 17.89, df = 1, $P < 0.05$).

The equation expressing the linear relationship between total length (TL) and the scale radius (R) was: TL = 105.06 R + 78.86 mm, ($r = 0.96$; $P \leq 0.001$). The ordinate to the origin of this equation (78.86 mm) corresponds to the theoretical fish size at the time of first scale formation. Comparison of successive monthly mean marginal increment values for scales using one-way ANOVA ($F = 7.63$; $P < 0.05$) revealed a significant difference between only two consecutive months, February and March (Fig. 2). Thus, the rings were considered to be annual increments.

Minimum values of marginal increment were recorded in March, which is the time of annulus formation.

TABLE I

Morphometric values and length-weight relationships for females, males, and unknown sex of Sander lucioperca *in the Ghrib reservoir, Algeria*

	N	r	Equation	Sy	Sx	Equation	r
	375	0.98	TL = 1.17 SL + 2.361	86.634	73.313	$TW = 0.0025\ TL^{3.317}$	0.98
Females	375	0.87	FL = 1.07 SL + 1.871	84.006	73.313	$EW = 0.0022\ TL^{3.327}$	0.98
	375	0.88	TL = 0.96 FL + 5.688	86.634	84.006	-	-
	474	0.99	TL = 1.20 SL + 1.334	72.291	59.841	$TW = 0.0047\ TL^{3.142}$	0.98
Males	474	0.97	FL = 1.09 SL + 1.205	66.518	59.841	$EW = 0.0042\ TL^{3.147}$	0.98
	474	0.97	TL = 1.07 FL + 1.015	72.291	66.518	-	-
Females	849	0.99	TL = 1.19 SL + 1.673	86.370	72.066	$TW = 0.0033\ TL^{3.237}$	0.98
+	849	0.93	FL = 1.08 SL + 1.667	80.693	72.066	$EW = 0.003\ TL^{3.271}$	0.98
Males	849	0.93	TL = 1.03 FL + 2.601	86.370	80.693	-	-

TL = overall length (cm); FL = length in the fork (cm); SL = standard length (cm); N = number of individuals; r = coefficient of correlation; Sy = standard deviation y; Sx = standard deviation x; TW = total weight; EW = eviscerated weight (g).

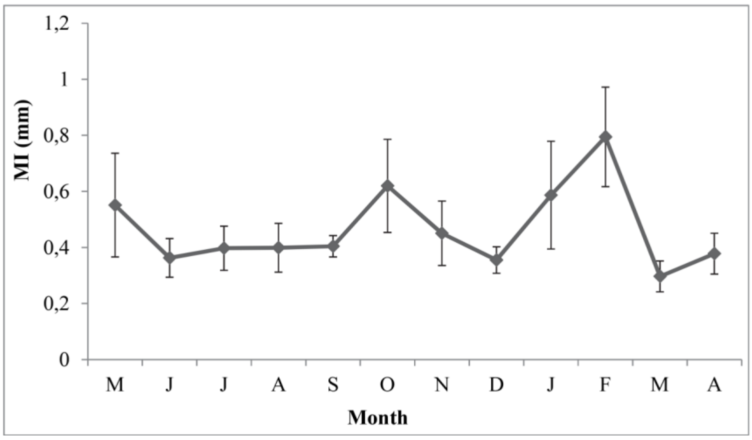

Figure 2.— Monthly evolution of marginal increment (MI) for all *Sander lucioperca* scales sampled from May 2013 to April 2014 at Ghrib reservoir, Algeria. Vertical error bars represent the standard deviation.

The age range of the sampled fish was 1-9 years, with of the majority (75.84 %) of individuals being in the 3-4 year age class (Tab. II). Back-calculated age-length pairs (Tab. III) did not reveal any difference from the observed mean size-at-age determined by direct reading of scales. The median values of the sizes corresponding to each size class were adjusted using the Von Bertalanffy equation: $TL = 125.72\ (1 - e^{-0,13\ (t\ +\ 0.89)})$ with r = 0.90 (Fig. 3). Growth performance index (*φ'*) was 3.31.

Analysis of the size distribution modes yielded estimates of age and growth (Tab. IV). The median values of the sizes corresponding to each size class were adjusted using a Von Bertalanffy equation: $TL = 132.17\ (1 - e^{-0.12\ (t\ +\ 0.95)})$ with r = 0.979 (Fig. 3). There was no significant difference between the results obtained using the two methods ($\chi 2$ calculated = 1.7 < $\chi 2$ theoretical = 14.07; P = 0.05).

TABLE II

Age-length key obtained by direct scale reading for Sander lucioperca *in the Ghrib reservoir, Algeria.*

Total length interval (cm)	Age (years) 1	2	3	4	5	6	7	8	9	N
20.5 – 22.5	3									3
22.5 – 24.5	19									19
24.5 – 26.5	24									24
26.5 – 28.5	25									25
28.5 – 30.5	3	5								8
30.5 – 32.5		11								11
32.5 – 34.5		18								18
34.5 – 36.5		25	0							25
36.5 – 38.5			45							45
38.5 – 40.5			96							96
40.5 – 42.5			128							128
42.5 – 44.5			81	33						114
44.5 – 46.5				109						109
46.5 – 48.5				47						47
48.5 – 50.5				36						36
50.5 – 52.5				28						28
52.5 – 54.5				29						29
54.5 – 56.5				12	17					29
56.5 – 58.5					22					22
58.5 – 60.5					11					11
60.5 – 62.5					5					5
62.5 – 64.5					0	2				2
64.5 – 66.5						5				5
66.5 – 68.5						0	1			1
68.5 – 70.5							2			2
70.5 – 72.5							0			0
72.5 – 74.5							0			0
74.5 – 76.5							2	0		2
76.5 – 78.5								2		2
78.5 – 80.5								0		0
80.5 – 82.5								0		0
82.5 – 84.5								1		1
84.5 – 86.5								0		0
86.5 – 88.5								0	2	2
N	74	59	350	294	55	7	5	3	2	849
%*N*	8.71	6.95	41.22	34.62	6.47	0.82	0.58	0.35	0.23	100
TL *M*	23.35	30.86	39.10	49.78	59.60	67.83	75.70	83.40	88.10	
E	1.94	1.71	1.68	3.37	1.86	0.94	3.71	4.02	0.14	

TL = total length; *N* = number of fish measured; *E* = standard deviation; *M* = mean.

DISCUSSION

We found no difference in relative growth of *S. lucioperca* based on TL/SL, TL/FL, and FL/SL, consistent with Copp *et al.* (2003); in the three types of length-length relationship, $\chi 2$ calculated = 0.99 < $\chi 2$ theoretical = 10.82; $p \leq 0.001$. Similarly, Goubier (1975) and Krpo-Cetkovic & Stamenkovic (1996) found no evidence for a difference in growth between the sexes.

TABLE III

Total length (cm) at the deposition of each growth ring in the scales of Sander lucioperca *from the Ghrib reservoir, Algeria*

Age		TL_1	TL_2	TL_3	TL_4	TL_5	TL_6	TL_7	TL_8	TL_9
I	N	74								
	M	21.50								
	E	1.91								
II	N	59	59							
	M	21.30	28.60							
	E	2.14	1.97							
III	N	350	350	350						
	M	21.80	31.30	37.70						
	E	2.10	2.12	1.83						
IV	N	294	294	294	294					
	M	21.90	28.20	39.10	47.60					
	E	2.10	1.95	1.94	3.74					
V	N	55	55	55	55	55				
	M	21.30	28.70	37.60	49.90	57.80				
	E	2.06	1.99	1.88	3.86	2.06				
VI	N	7	7	7	7	7	7			
	M	21.70	28.50	37.80	48.70	59.90	66.80			
	E	2.09	1.97	1.88	3.85	2.14	1.65			
VII	N	5	5	5	5	5	5	5		
	M	21.50	28.60	37.30	48.60	58.80	67.20	74.90		
	E	2.07	1.98	1.86	3.76	2.1	1.66	0.51		
VIII	N	3	3	3	3	3	3	3	3	
	M	21.40	28.80	37.30	48.40	58.70	66.90	74.80	82.90	
	E	2.06	1.99	1.85	3.82	2.09	1.65	0.50	5.01	
VIIII	N	2	2	2	2	2	2	2	2	2
	M	21.40	28.60	37.60	48.60	58.80	66.90	74.70	81.70	86.90
	E	2.06	1.98	1.85	3.77	2.0	1.65	0.48	4.13	0.15
Total	N	849	775	716	366	72	17	10	5	2
	M	21.53	28.91	37.77	48.63	58.80	66.95	74.80	82.30	87.70
	E	1.95	2.02	1.86	3.22	1.80	1.40	3.77	2.48	0.17

N = number of fish sampled; *M* = mean of the length; *E* = standard deviation. TL_1 to TL_9 are the back-calculated sizes-at-age.

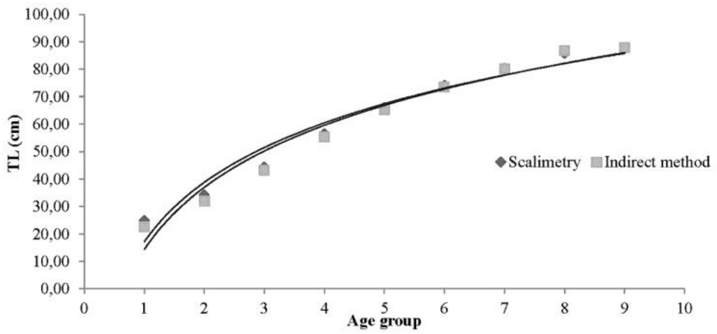

Figure. 3 — Theoretical curves of the growth in length of *Sander lucioperca* from Ghrib reservoir, Algeria. TL = length at the time of growth ring deposition (calculated using Von Bertalanffy model).

Scale marginal increment values suggest that only one growth ring is formed annually, in February. The high percentage of scales with hyaline edges observed at the end of the winter and the beginning of spring may reflect physiological stress during the spawning season (February-May) (Poulet, 2004). These months also constitute the period during which the temperatures in the Ghrib reservoir are the lowest, close to 6.5°C.

TABLE IV

Growth parameters and age of Sander lucioperca *from the Ghrib dam, Algeria, estimated by direct (scale method) and indirect (pseudocohort analysis) methods*

Parameters	L_∞ = 125.72 (cm) k = 0.13 year $^{-1}$ t_0 = -0.89 year		L_∞ = 132.17 (cm) k = 0.12 year $^{-1}$ t_0 = -0.95 year	
Age group	Direct method		Indirect method	
	Sizes observed (cm) (Scalimetry)	Sizes calculated (cm) (Von Bertalanffy)	Sizes observed (cm) (Bhattacharya)	Sizes calculated (cm) (Von Bertalanffy)
I	24.90	23.80	22.57	22.87
II	34.20	32.50	31.90	32.50
III	44.40	43.20	43.20	43.70
IV	56.50	55.40	55.40	56.24
V	66.00	65.10	65.23	65.35
VI	74.20	73.30	73.48	73.67
VII	80.40	79.80	80.17	80.64
VIII	85.80	84.70	86.73	86.93
VIIII	87.60	86.40	87.90	88.20

TABLE V

Growth parameters (L_∞, k, t_0), growth performance indexes (φ'), and parameters for the weight-length relationship (a, b) of Sander lucioperca *at different localities*

Locality and author	*a*	*b*	L_∞	*k*	t_o	*φ'*
Sidi-Salem dam, Tunisia (Toujani, 1998)				3	24	6
Seyhan Dam Lake, Turkey (Özyurt & Avşar, 2002)	-	-	54.44	0.094	-3.346	2.44
German coastal waters, Baltic Sea (Hahlbeck & Müller, 2003)	0.0032	3.283	141.3	0.085	-1.354	3.23
Hirfanli Dam Lake, Turkey (Ablak & Yilmaz, 2004)	10×10^{-6}	3.07	-	-	-	-
Lake Iğirdir, Turkey (Balik *et al.*, 2004)	0.006	3.148	95.4	-0.084	1.563	2.88
Lake Eğirdir, Turkey (İzci & Kuşat, 2006)	0.022	2.742	156.95	-0.045	2.622	3.04
Iranian coastal waters, Caspian Sea (Abdolmalaki & Iwona Psuty, 2007)	-0.0206	2.85	55.05	0.15	-2.59	2.65
Southern Finland (Milardi *et al.*, 2011)	0.00217	3.371	69.56	0.10	-0.12	2.63
Tunisian reservoirs (M'Hetli e*t al.*, 2011)	5×10^{-6}	3.06	-	-	-	-
French reservoir (Argillier *et al.*, 2012)	1.91×10^{-6}	5	8	3	38	4
Nature Reserve "Koviljsko-Petrovaradinski Rit", Serbia (Lujić *et al.*, 2013)	-	-	49.55	0.25	-0.01	2.78
Lake Marmara, Turkey (Ilhan & San, 2015)	0.0091	2.996	-	-	-	-
Ghrib dam (Present study)	0.0033	3.237	125.72	0.13	-0.89	3.31

Nine age-classes were documented in the current study. This is almost similar to results obtained in the Camargue, France (7 year classes; Poulet, 2004), higher than the numbers estimated for the Sidi-Salem dam, Tunisia (6, Toujani & Kraiem, 2002) and in Turkish reservoirs (5, Ablak & Yilmaz, 2004; Balik *et al.*, 2004), but lower than the numbers in two French reservoirs (14, Argillier *et al.*, 2012) and in Lake Peipsi, Estonia (10, Kangur & Kanguur, 1996) where the species is native compared with the other areas where it is introduced. However, these differences may be the result of insufficient and/or biased sampling methods or to overfishing resulting in smaller size-at-age (Boughamou *et al.*, 2015).

The exponent of the length-weight relationship (*b* value) for Ghrib reservoir indicates positive allometric growth (*b* = 3.23) (Tab. V). This value is comparable with those found for populations in Europe, including France (*b* = 3.25) (Argillier *et al.*, 2012) and German coastal waters of the Baltic Sea (*b* = 3.28) (Hahlbeck & Müller, 2003), and in Asia (Turkey: *b* = 3.14; Balik *et al*., 2004). The allometry coefficients of the length-weight relationship in Turkey (*b* = 3.07, Ablak & Yilmaz, 2004), *b* = 2.996, Ilhan & San, 2015) and in Tunisia (*b* = 3.06, M'Hetli *et al.*, 2011) indicate isometric growth. Interestingly, in Turkey (İzci and Kuşat, 2006) and Iranian coastal waters of the Caspian Sea (Abdolmalaki & IwonaPsuty, 2007) *S. lucioperca* exhibits a completely different pattern of growth (coefficient of allometry *b* = 2.74 and *b* = 2.85, respectively). This geographical variation in the coefficient of allometry may reflect the degree of acclimatization of *Sander lucioperca* to its location. However, the rate of allometry is known to vary among species, location in time and space (e.g. in relation to hydro-biological conditions, availability of food, sex, and maturity), and the demographic structure of the population (density and thus trophic competition); disease and parasite loads can also affect the value of *b* (Le Cren 1951; Bagenal & Tesch, 1978).

In Ghrib reservoir, the first annual deceleration of *S. lucioperca* growth occurs at a larger size (L_1 = 22 cm) than in the lakes and reservoirs of Europe: Lake Orsjön (L_1 = 8.3 cm, Svärdson & Molin, 1973), Lake of Créteil (L_1 = 9.1cm, Gerdeaux, 1986), the Danube, Hungary (L_1 = 17.8 cm, Schmid, 1995), Lake Peipsi (L_1 = 12.3 cm, Kangur & Kanguur, 1996) and in the "Koviljsko-Petrovaradinski Rit" nature reserve (L_1 = 15.72 cm, Lujić *et al.,* 2013).

The results of the size frequency analysis corroborate those of the scale analysis. The Von Bertalanffy growth parameters obtained in this study and those from other studies are given in Table V. The asymptotic length (L_∞) calculated in this study is relatively high compared to those from other areas: Sidi-Salem dam (Toujani, 1998), Seyhan dam (Özyurt & Avşar 2002), Lake Iḡirdir (Balik *et al.,* 2004), Caspian Sea (Abdolmalaki & Iwona Psuty, 2007), Southern Finland (Milardi *et al.,* 2011), a French reservoir (Argillier *et al.,* 2012), and the "Koviljsko-Petrovaradinski Rit" nature reserve (Lujić *et al.,* 2013). However, they are not different from values from the German coastal waters of Baltic Sea (Hahlbeck & Müller, 2003) and Lake Eğirdir in Turkey (İzci & Kuşat, 2006). The growth performance index (φ' = 3.31) was higher in fish from Ghrib reservoir compared to those from other areas, except on the Tunisian Sidi-Salem dam (Toujani, 1998) (Tab. V). We speculate that the range in sizes (L_∞) estimated for the same species reflects the specificity and the ecological characteristics of the environment where the fish lives. For example, water temperature can directly affect fish growth by influencing the physiology of fish (Weatherley & Gill, 1987).

The growth of age 1 and older individuals in Ghrib reservoir appears to be among the most rapid observed for the species (Fig. 3). This exceptional growth may be because it is southernmost population within the range. The optimum temperature for the growth of the *S. lucioperca* is ~28-30°C (Hokanson, 1977; Hilge, 1990) but these temperatures are seldom reached in the high latitudes and, if that happens, it is only over short periods. One thus expects to observe very different growth rates according to the latitude in which the population is located. The positive influence of temperature on the growth of the *S. lucioperca* in the current study is consistent with observations of Ložys (2004) and Heikinheimo *et al.* (2014).

The trophic conditions (quality and quantity of food) are also likely to influence growth. For example, individual zooplanktonivores grow less rapidly than their congeneric piscivores (Mooij *et al.,* 1994; Frankiewicz *et al.,* 1996). In Ghrib reservoir, pike perch preys primarily on roach, which is abundant. Interestingly, no native species (barbel) were found in the stomach of pike perch.

The maximum length of *S. lucioperca* observed in Ghrib reservoir was among the highest recorded, with individuals of > 85.0 cm (Tab. IV). Given the geographical location of the Ghrib population, this is somewhat surprising as Bergmann (Mayr, 1956) suggests that individuals at high latitudes are larger than congeneric individuals at lower latitudes. However this rule is often subject to exceptions (Jonsson, 1991). Other factors such as trophic resources can influence the maximum size. There is still a need for additional work on the growth of the *S. lucioperca* throughout its range to understand the factors affecting its growth.

CONCLUSION

We determined the age and growth parameters of *S. lucioperca* by scalimetry and by analysis of size frequencies. Statistically, there was no significant difference between the results obtained using the two methods. Thus, either method could be used to obtain growth data for *S. lucioperca*. The exceptional growth observed in *S. lucioperca* in the Ghib reservoir reflects the adaptive capacity of the species and explains, in part, its ability to colonize new environments. The Mediterranean climate, combined with the high thermal optimum for *S. lucioperca* growth, likely largely explains this phenomenon. Our results suggest that the introduction of *S. lucioperca* to the northwest Algerian reservoir has been successful. The tolerance of this introduced species appears to allow self-sustaining populations to persist; however, no study has yet been conducted in Algeria on its possible ecological impact. Nevertheless our results can be used as a starting point for evaluating the population dynamics of *S. lucioperca* in Algeria and estimating its population size.

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